PATENT ABSTRACTS OF JAPAN

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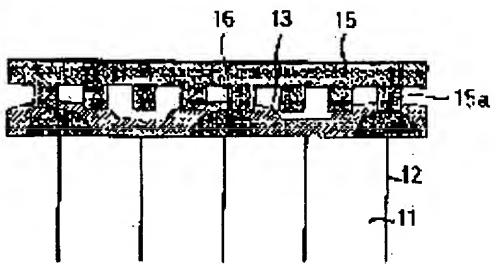
(54) MULTILAYERED PIEZOELECTRIC ELEMENT

(57)Abstract:

PURPOSE: To provide a multilayered piezoelectric element which can prevent the failure like peeling, by surely connecting an outer electrode with inner electrodes every other layer, preventing imperfect conduction and imperfect insulation, and intensely bonding the outer electrode to an element main body.

CONSTITUTION: On the side surface of a multilayered member wherein piezoelectric material films 11 and inner electrodes 12 are alternately overlapped, conductive protruding parts 16 are formed every other layer, and an insulating film 13 is formed so as to cover all the piezoelectric material films 11 in the laminating direction of the element. A copper foil 15 having protrusions 15a is formed as an outer electrode on the insulating film 13. The outer electrode is electrically connected with the inner electrodes by bringing the protrusions 15a into contact with the conductive protruding parts 16.



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* NOTICES *

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] this invention carries out several multi-sheet laminating of the thin film of piezoelectric material, and relates to the laminating type piezoelectric device which obtains a lengthwise variation rate by impressing voltage.
[0002]
[Description of the Prior Art] although it is necessary to connect an internal electrode to an external electrode setting further when manufacturing a laminating type piezoelectric device conventionally, if the conventional multilayer-capacitor method is used -- since internal-electrode area is smaller than the cross section of an element -- electric field -- the whole surface -- not generating -- a portion not only checking a variation rate but uneven -- stress concentration -- generating -- just -- being alike -- there is a fatal fault of destroying moreover, positioning at the time of a laminating -- difficult -- at most -- the case where about dozens of laminating number of sheets is limitations, and it is the same applied voltage -- the variation rate of an element -- since an amount is proportional to laminating number of sheets -- a big variation rate -- it was difficult to manufacture the element which generates an amount In order to cancel this fault, the method of printing and carrying out the laminating of the electrode all over a piezo-electric sheet, i.e., the structure which makes area of an internal electrode and area of an element equal, is general. And the method as shown in drawing 8 and drawing 9 is considered as the example.
[0003] First, as shown in drawing 8 (a), a laminating is carried out, it sinters and a sintered compact 70 is formed so that the edge of an internal electrode 72 may expose the piezoelectric material 71 of the shape of a film by which the internal electrode 72 was printed to setting further. And the edge of an internal electrode 72 applies the temporary external electrodes 73 and 74 to the side exposed to setting further, and if electroplating is performed by using the temporary external electrode 73 as cathode, as shown in drawing 8 (b), the conductive heights 75 by the electroplating method will be in the state where it was formed for setting further.
[0004] Hereafter, drawing of longitudinal section of a sintered compact 70 explains. If the conductive heights 75 and the edge of an internal electrode 72 are made to electrodeposit a resinous principle 76 by electropainting etc. and it burns before and after 150 degrees C as shown in drawing 9 (a), as shown in drawing 9 (b), an insulating layer 77 will be formed.
[0005] The anisotropy electric conduction film 78 which thermocompression bonding was possible, and only the pressurization portion had the conductivity to ** on the other hand, and contained the conductive particle 80 on the other hand as shown in drawing 9 (c), As what stuck the copper foil 79 used as an external electrode is prepared and it is shown in drawing 9 (d) When thermocompression bonding is carried out, the anisotropy electric conduction film 78 will be partially pressurized by the pressure only with the conductive heights 75 and the portion which countered higher than other portions. Consequently, the conductive particle 80 of the portion pressurized by the high pressure will break through an insulating layer 77, the conductive heights 75 and copper foil 79 will be contacted, and the internal electrode 72 placed further is electrically connected to copper foil 79.

[0006] The sintered compact 70 which connected the internal electrode and copper foil which shift a layer and set it further on the side of an opposite side by the same method serves as a finished product through processes, such as installation of lead wire, resin sheathing, and polarization processing.
[0007]
[Problem(s) to be Solved by the Invention] However, in the above laminating type piezoelectric devices, the insulating layer 77 was broken through, and since the conductive particle 80 was used as a medium which connects the external electrode 79 and an internal electrode 75, the following problems arose.
[0008] Flowing [the layer which can do the layer to which the conductive particle 80 does not reach to the conductive heights 75, and is not electrically connected even if it is pressurized, since there is dispersion in the size of the particle of the conductive particle 80 and the distributed state also changes with places, or does not have the conductive heights 75 conversely and which should originally be insulated] ******. Moreover, the adhesive strength of copper foil 79 might become weak by existence of the conductive particle 80, and it might separate during the drive of an element.
[0009] this invention aims at offering the laminating type piezoelectric device which can prevent defects, such as peeling, by pasting up an external electrode and an element main part powerfully while it is made in order to solve the trouble mentioned above, and it connects with the internal electrode which places an external electrode further certainly and it prevents defective continuity and poor insulation.
[0010]
[Means for Solving the Problem] In order to attain this purpose the laminating type piezoelectric device of this invention In the side of a layered product in which the laminating of piezoelectric material and the internal electrode is carried out by turns The aforementioned whole side of a layered product in which the conductive heights formed in the edge of the internal electrode set further and the aforementioned conductive heights were formed A wrap insulator layer, By height's having the salient of equal a large number uniformly in the aforementioned layered product and the field which counters, and compressing towards a layered product from the upper surface side of the aforementioned insulator layer Each aforementioned salient broke through the aforementioned insulator layer, and is equipped with the external electrode electrically connected with the aforementioned internal electrode through the aforementioned salient in contact with each aforementioned conductive heights.
[0011] Moreover, it is desirable to form more narrowly than the width of face of the aforementioned conductive heights the width of face of each salient of the aforementioned external electrode.
[0012] Furthermore, it is desirable to arrange each aforementioned salient to an external electrode at an interval to which two or more aforementioned salients exist among ****** aforementioned each conductive heights comrade.
[0013]
[Function] The laminating type piezoelectric device of this invention which has the above-mentioned composition Since the salient which breaks through the aforementioned insulator layer and contacts conductive heights is formed in one with the external electrode and height is moreover formed equally uniformly To each conductive heights, at least one aforementioned salient contacts certainly, an internal electrode and an external electrode are electrically connected through conductive heights, and the internal electrode in which conductive heights are not formed insulates certainly, in order that the aforementioned salient may not contact.
[0014]
[Example] Hereafter, the example which materialized this invention is explained with reference to a drawing.
[0015] The cross section of the laminating type piezoelectric device by this invention is shown in drawing 1 . In the side of a layered product in which the piezoelectric-material film 11 and an internal electrode 12 lap by turns, while the conductive heights 16 are formed for setting further, the insulator layer 13 is formed so that all the piezoelectric-material films 11 may be started in the direction of a laminating of an element. Furthermore, on it, copper foil 15 with salient 15a is formed as an external electrode, and this external electrode is electrically connected with the internal electrode 12 through the

conductive heights 16.
[0016] Next, the manufacture method of a laminating type piezoelectric device shown in drawing 1 is explained with reference to a drawing.
[0017] First, after mixing the piezoelectric material which makes PZT (titanic-acid lead zirconate) a principal component to desired composition, add the binder of 5 weight sections, the plasticizer of a minute amount, and a defoaming agent to the powder which carried out temporary baking at 850 degrees C, and it is made to distribute in an organic solvent, and is made the shape of a slurry. This slurry is fabricated in predetermined thickness by the doctor blade method, and it considers as a green sheet. Pd (palladium) paste is screen-stenciled as an internal electrode 12 on this green sheet, the predetermined number-of-sheets laminating of what was pierced in the predetermined size is carried out, and it unifies with a heat press. As it sinters at about 1200 degrees C after degreasing and is shown in drawing 2 , it cuts so that application baking of the temporary external electrodes 22 and 23 may be carried out and the sides 24 and 25 of still more nearly another couple may be exposed to the sintered compact 21 cut in a position which an internal electrode 12 exposes to setting further.
[0018] And in one side 24 of a sintered compact 21, where it left the portion which forms the conductive heights 16, and it masked all other portions on the tape and the side 25 whole of another side is masked on a tape, the temporary external electrode 22 is connected to the negative electrode of DC power supply, and it sinks during a nickel-plating bath. If nickel plating grows up to be the internal electrode 12 which will be connected with the temporary external electrode 22 if 50mA current is passed for about 5 minutes in this state and a masking tape is removed, as shown in drawing 3 , the conductive heights 16 made from nickel plating will be in the state where it was formed for placing further. Next, after masking and protecting on a tape the whole side 24 in which the conductive heights 16 were already formed, and a part of side 25 for a layer to be shifted also on the side 25 of an opposite side, and form the conductive heights 16, a negative electrode is connected to the temporary external electrode 23, and nickel plating is grown up. Thereby, also in the side 25, it shifts from the side 24 every further, and the conductive heights 16 are formed.
[0019] If the negative electrode of DC power supply is connected to the temporary external electrodes 22 and 23 after washing, it sinks during the epoxy cation electrodeposition-paint bath which added the pigment of the specified quantity and the voltage of 100V is applied for 2 minutes, as shown in drawing 4 , an epoxy cation electrodeposition paint electrodeposits the internal electrode 12 in which an epoxy cation electrodeposition paint electrodeposits the internal electrode 12 in which the conductive heights 16 are formed on the front face of the conductive heights 16, and the conductive heights 16 are not formed at the edge. Then, since it has a fluidity in the process which an epoxy resin component hardens when it heat-treats for 30 minutes at 150 degrees C in oven, as shown in drawing 5 , flattening is carried out, and it becomes an insulator layer 13.
[0020] Moreover, as it is independently indicated in drawing 6 as a sintered compact 21, by processing it with a roller etc., much salient 15a is formed in one side of copper foil 15, and what applied thermosetting epoxy system adhesives to the front face is prepared. This salient 15a is formed at an interval to which it is formed by about about 1/4 width of face of the width of face of the conductive heights 16, and these about three salient 15a exists among ****** conductivity heights 16 comrades.
[0021] This is cut in a size which is applied to the sides 24 and 25 of a sintered compact 21 at each conductive heights, as shown in drawing 7 , and it carries out [tacking] so that salient 15a and an insulator layer 13 may face each other. And if it inserts with the fixture 53 for pressurization of the plane of the couple heated at about 180 degrees C (as for drawing 7 , an unilateral side illustrates only **) and thermocompression bonding is carried out, applying a several kg load It is partially pressurized by the pressure only with the portion of conductive heights higher than other portions. Consequently, as shown in drawing 1 , salient 15a of copper foil 15 breaks through an insulator layer 13, only the portion pressurized by the high pressure contacts the conductive heights 16, and the internal electrode 12 placed further will be in the state where copper foil 15 was connected.
[0022] And after the sintered compact 21 which connected copper foil 15 to each internal electrode 12 which shifts a layer and is mutually placed further on each sides 24 and 25 of the reverse sense is cut by

the amount of one element, it attaches the lead wire for electric power supplies in a part of copper foil 15, performs resin sheathing and polarization processing, and serves as a finished product.
[0023] Thus, it sets to the laminating type piezoelectric device of this example. Since salient 15a which breaks through an insulator layer 13 and contacts the conductive heights 16 is formed in one with the external electrode 15 and height is moreover formed equally uniformly The internal electrode 12 in which at least one salient 15a contacts certainly, and an internal electrode 12 and the external electrode 15 are electrically connected to through conductive heights to each conductive heights 16, and the conductive heights 16 are not formed insulates certainly, in order that salient 15a may not contact.
[0024] Moreover, since the adhesion area of the external electrode 15 and an element main part increases and the external electrode 15 and an element main part can be powerfully pasted up by having salient 15a as compared with the former, defects, such as peeling, can be prevented.
[0025] Furthermore, in this example, since it is about about 1/4 width of face of the width of face of the conductive heights 16 and each salient 15a is formed comparatively narrowly, it is easy to break through an insulator layer 13, and copper foil 15 can be connected with an internal electrode 12 by the comparatively weak pressure. And since it is formed among [about three] ****** conductivity heights 16 comrades at an interval which exists, even if salient 15a sticks copper foil 15 by pressure to the number of the conductive heights 16, without much salient 15a's existing and positioning in the array direction, it can contact one of salient 15a to each conductive heights 16 certainly.
[0026] In addition, this invention is not limited to the example mentioned above, and unless it deviates from the main point, it can add various change. For example, the same effect can be acquired even if it uses chrome plating and copper coating instead of nickel plating. Moreover, as long as connection with each conductive heights placed further is possible, the number, the width of face, and the interval of a salient can be changed arbitrarily, and the configuration may be formed in the mountain type configuration and the wave type configuration where not only a rectangle but the nose of cam became thin.
[0027]
[Effect of the Invention] the Ming kana since it explained above -- since generating with poor defective continuity and insulation can be prevented since it is certainly connectable for setting an external electrode and an internal electrode further, and an external electrode can be powerfully pasted up on a layered product like according to the laminating type piezoelectric device of this invention, defects, such as peeling, can be prevented

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the cross section of the laminating type piezoelectric device of this example.
[Drawing 2] It is the perspective diagram of the cut laminating sintered compact.
[Drawing 3] It is the perspective diagram of the sintered compact in the state where conductive heights were formed.
[Drawing 4] It is the cross section showing the state where the epoxy cation electrodeposition paint was electrodeposited.
[Drawing 5] An epoxy KACHIN electrodeposition paint is the cross section showing the state where it flowed by heating.
[Drawing 6] It is the cross section of copper foil with which the salient was formed.
[Drawing 7] It is explanatory drawing showing the state of pressurizing the copper foil in which the salient was formed at a layered product.
[Drawing 8] It is explanatory drawing of the conventional laminating type piezoelectric device.
[Drawing 9] It is explanatory drawing of the conventional laminating type piezoelectric device.
[Description of Notations]
11 Piezoelectric-Material Film
12 Internal Electrode
13 Insulator Layer
15 Copper Foil
15a Salient
16 Conductive Heights

[Translation done.]

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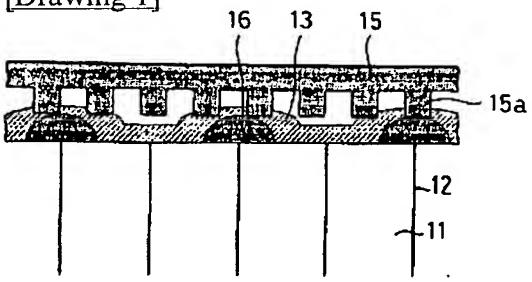
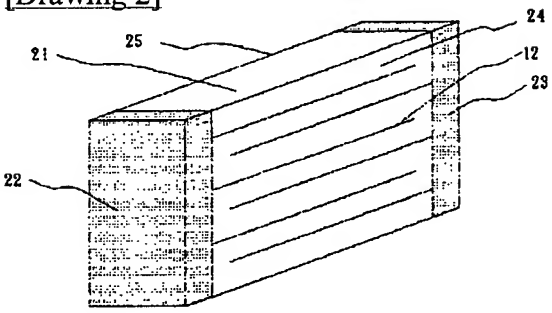
DRAWINGS

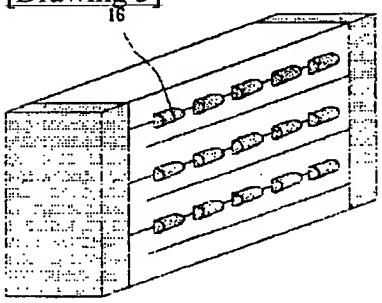
[Drawing 1]



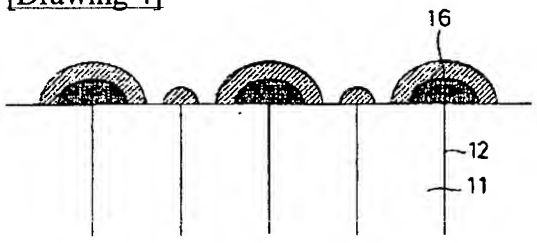
[Drawing 2]



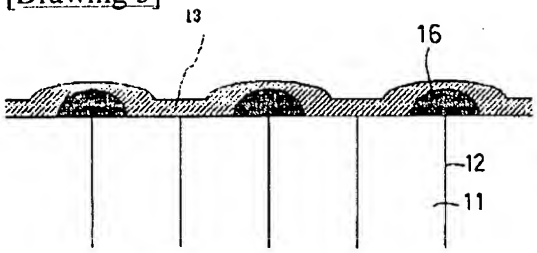
[Drawing 3]



[Drawing 4]

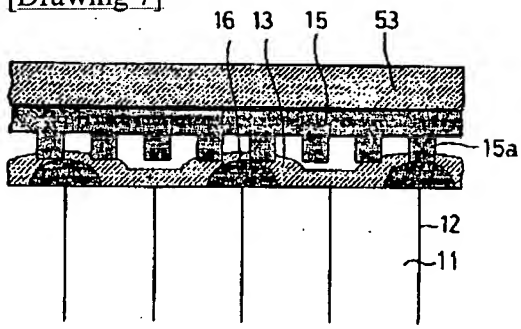


[Drawing 5]



[Drawing 6]

[Drawing 7]



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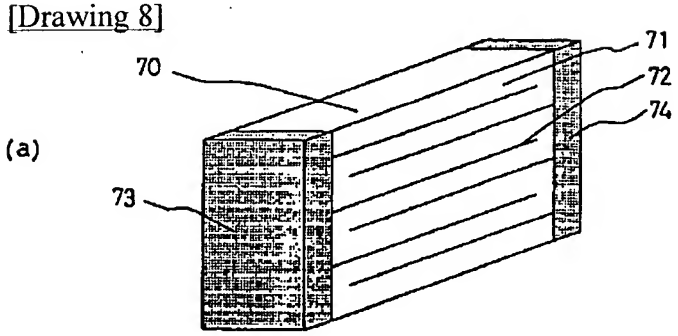
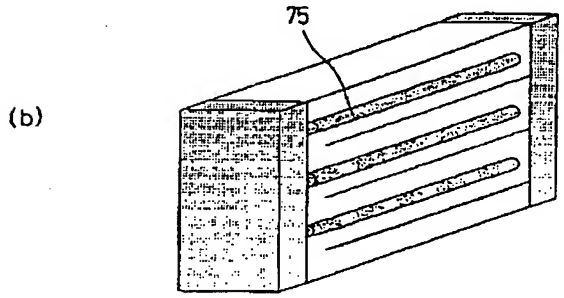
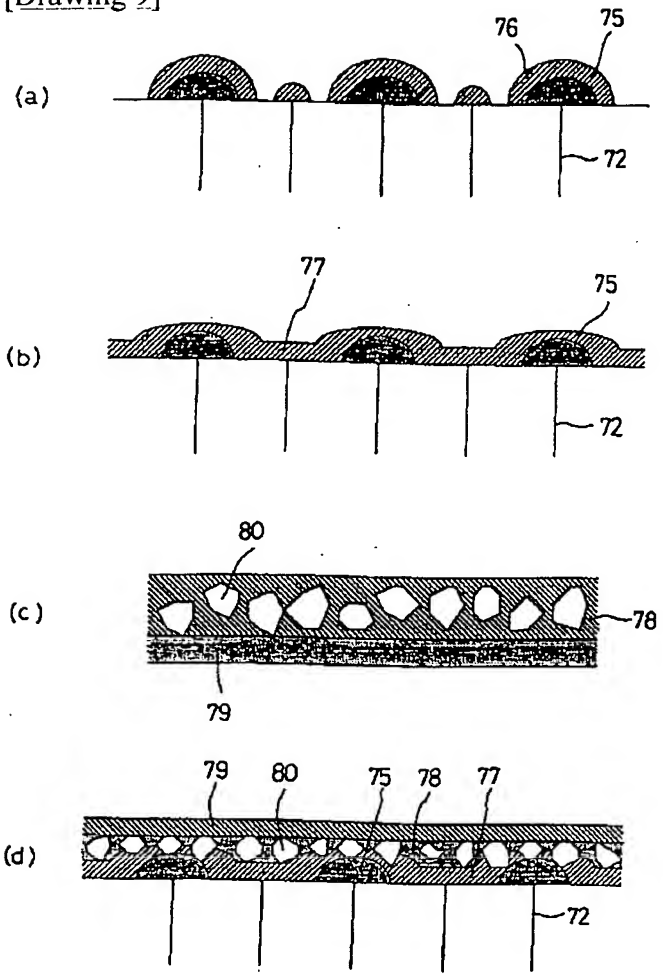




[Drawing 9]



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